HYDROLOGY

Precipitation

Average annual precipitation for the Crooked River basin ranges from 36 to 38 inches (Vandike 1995). Average annual runoff is about 8.5 inches (Vandike 1995). Seventy percent of the rainfall occurs during the growing season (Preston 1986). Annual snowfall is about 20 inches (MDNR 1986a) with about 30 days of continuous snow cover (Detroy and Skelton 1983).

Gauging Stations

The two gauging stations in the Crooked River basin are both located near Richmond, Missouri. The gauge on the mainstem Crooked River (number 06895000; in operation from 1948 through 1970) was a continuous-record streamflow gauging station, located at the Highway 13 bridge, 4 miles north of Richmond and records data for a drainage area of 159 square miles. The other gauge (number 06895050; a low-flow station) located on the West Fork Crooked River at Richmond recorded data in 1943, 1945, 1946, 1953, and 1962 (Detroy and Skelton 1983).

Permanent and Intermittent Streams

The mainstem Crooked River was classified as permanently flowing for 30 miles and intermittently flowing for 30 miles in 1968. Estimates for the Crooked River basin, including the East and West Fork Crooked rivers, were 47 miles of permanent flowing and about 35 miles of intermittent flowing streams (Funk 1968).

There are 59 third order and larger streams in the Crooked River basin with a total stream mileage of 371 miles (Appendix B). The permanence/intermittence of particular streams can be determined from 7.5 minute series topographical maps found in the coverage in Appendix B. Permanent streams are indicated with solid blue lines and intermittent streams are indicated with dashed blue lines. Based on current USGS 7.5 minute maps there are 177 miles of permanently flowing and 50 miles of intermittently flowing streams and rivers, fourth order or higher, in the Crooked River basin. Most third order and lower streams in the basin are intermittent. Increased intermittence resulting from lower base flows and sedimentation is occurring throughout the basin. Crooked River basin streams suffer from poor baseflows due to the relatively impermeable nature of basin soils (MDNR 1986b).

Stream Flow

Average annual discharge for the gauging station on the mainstem Crooked River was about 99 cubic feet per second (DuCharme and Miller 1996). Lowest discharge usually occurs

midwinter and highest discharge in the summer months (Figure 3). The highest recorded flow was 29,000 cubic feet per second on July 20, 1965 (Vandike 1995). Periods of no flow have occurred in the Crooked River (Vandike 1995).

7 Day Q_2 and Q_{10} Low Flows

Streams in the Dissected Till Plains Region, including the Crooked River, have poor low flow potentials due to low hydraulic conductivity of area soils and poor land use practices. Low flows in the basin usually occur in the months of August, September and October (Skelton 1976). Low flow characteristics

can usually be generalized in plains streams based upon the size of the drainage area. Streams with basin areas less than 100 mi^2 will almost always have 7-day average minimum flows at recurrence intervals of two years (7-day Q_2) of zero. About 60 percent of plains streams with drainage areas of 100 to 200 mi^2 will have 7-day Q_2 of zero and the remainder will have 7-day Q_2 of 0.1 to 1.0 cfs. This method is unreliable for basins with drainage areas larger than 200 mi^2, and field observations are required. The 7-day average minimum flows at 10 year intervals (7-day Q_{10}) for drainage basins of 200 mi^2 or less are almost always zero. About 70 percent of plains streams with drainage areas of 200 to 1,000 mi^2 will have 7-day Q_{10} of zero and the remainder will have 7-day Q_{10} of 0.1 to 1.5 cfs (Skelton 1976). Lowest mean discharge in the Crooked River for 7 days consecutively is zero (Skelton et al. 1982). The 7 day Q_2 is 0.2 and 7 day Q_{10} is zero (MDNR 1995). The flow duration curve (Figure 4) indicates the Crooked River basin has highly variable flows. Basin streams tend to rise and subside swiftly in response to precipitation events.

Dam and Hydropower Influences

There are no major dams in the basin. There are a few small public and private lakes and a large number of farm ponds in the Crooked River basin. In the early 1980's it was estimated that Ray County contained 3,500 small impoundments (Preston 1986). Due to small size and ease of construction, the number of ponds can change very rapidly. Many ponds are built without needing permits and statistics on ponds are usually compiled by county rather than watershed. These factors complicate getting accurate, up-to-date information on ponds. Concern exists over the effects these ponds have on low-flow conditions as they intercept runoff and allow little or no adjustment for maintenance of stream flows.

Appendix B. Stream information for third order and larger streams from the Crooked River basin obtained from 7.5 minute series, 1:24,000 scale, USGS topographic maps. (Original length and miles channelized for all streams fourth order and larger were estimated using 7.5 minute series, 1:24,000 scale, USGS orthophoto quadrangle maps).

Table B -1. Stream information for third order and larger streams from the Crooked River basin obtained from 7.5 minute series, 1:24,000 scale, USGS topographic maps. (Original length and miles channelized for all streams fourth order and larger were estimated using 7.5 minute series, 1:24,000 scale, USGS orthophoto quadrangle maps).

Stream Name	Max. Order	Location at Mouth T R S	Map Numbers[1]	Receiving Stream	Original Length (Mi.)	Current Length (Mi.)	Miles Channe l-ized
Crooked River	6	51-26-14	S17, R17, R16, R15, Q15, Q14, P14, P13	Missouri River	78	71	5
Unnamed #01	3	51-26-08	S17, S16, R16	Crooked River		7	
Dangerous Branch	3	52-26-30	R17	Crooked River		6	
East Fork Crooked River	5	52-27-23	R16, Q16, P16	Crooked River	35	33	1
Unnamed #02	3	52-27-11	R16, R17	East Fork Crooked River		5	
Unnamed #03	3	53-27-35	R16, Q16	East Fork Crooked River		4	
Unnamed #04	3	53-27-35	R16, Q16	East Fork Crooked River		4	
Unnamed #05	4	53-27-09	Q16, P16	East Fork Crooked River		9	0
Unnamed #06	3	54-27-28	Q16	Unnamed #05		4	
Unnamed #07	3	54-27-21	Q16	Unnamed #05		3	
Unnamed #08	4	54-27-29	Q16, Q15, P15	East Fork Crooked River	14	13	2
Unnamed #09	3	54-27-30	Q16, Q15	Unnamed #08		3	
Unnamed #10	3	54-28-24	Q16, Q15	Unnamed #08		2	
Unnamed #11	3	54-28-11	Q15, P15	Unnamed #08		2	
Unnamed #12	3	54-28-11	P15	Unnamed #08		4	
Unnamed #13	3	55-28-35	P15	Unnamed #08		3	
Unnamed #14	3	54-27-17	Q16, P16	East Fork Crooked River		4	
West Fork Crooked River	4	52-27-27	R16, R15, R14	Crooked River		22	0
Unnamed #15	3	52-27-19	R16, R15	West Fork Crooked River		4	
Unnamed #16	3	52-28-21	R15	West Fork Crooked River		7	
Unnamed #17	3	52-27-08	R16	Crooked River		4	
Cottonwood Branch	3	52-27-07	R16, Q16	Crooked River		7	
McDonald Branch	4	53-28-36	R16, R15, Q15	Crooked River	7	7	1
Unnamed #18	3	53-28-26	R15, Q15	McDonald Branch		4	

Stream Name	Max. Order	Location at Mouth T R S	Map Numbers[1]	Receiving Stream	Original Length (Mi.)	Current Length (Mi.)	Miles Channe l-ized
Unnamed #19	3	52-28-02	R15	Crooked River		1	
Rocky Fork	4	53-28-28	R15, Q15, Q14	Crooked River	12	11	1
Unnamed #20	3	53-28-29	R15	Rocky Fork		3	
Unnamed #21	3	53-29-24	Q15, Q14, R14	Rocky Fork		4	
Unnamed #22	3	53-29-14	Q15, Q14, R14	Rocky Fork		3	
Fire Branch	3	53-28-09	Q15, P15	Crooked River		12	
Kings Branch	3	53-28-06	Q15, Q14	Crooked River		4	
Coon Branch	3	54-29-25	Q15, Q14	Crooked River		5	
Cockerel Creek	4	54-28-19	Q15, P15	Crooked River	6	6	1
Unnamed #23	3	54-28-18	Q15, P15	Cockerel Creek		3	
Unnamed #24	3	54-29-11	P14, P15	Crooked River		2	
Burnt Fork	4	54-29-09	P14, Q14	Crooked River	7	7	1
Unnamed #25	3	54-29-09	P14	Burnt Fork		1	
Unnamed #26	3	54-29-10	P14	Crooked River		2	
Unnamed #27	3	54-29-03	P14	Crooked River		3	
Unnamed #28	4	55-29-33	P14	Crooked River		4	0
Unnamed #29	3	55-29-27	P14	Unnamed #28		2	
Brushy Creek	4	55-29-33	P14, Q14	Crooked River	16	14	1
Unnamed #30	3	54-29-05	P14	Brushy Creek		2	
Unnamed #31	3	54-29-08	P14	Brushy Creek		2	
Unnamed #32	4	54-29-18	Q14, P14, P13	Brushy Creek		7	0
Unnamed #33	3	54-30-12	Q14, P14	Unnamed #32		1	
Unnamed #34	3	54-30-11	P14	Unnamed #32		2	
South Prong	4	55-29-28	P14	Crooked River	6	6	1
Unnamed #35	3	55-29-31	P14	South Prong		1	
Spring Branch	4	55-29-29	P14	Crooked River	5	4	1
Unnamed #36	3	55-29-20	P14	Spring Branch		2	
Stevenson Creek	4	55-29-29	P14, P13	Crooked River	11	10	1
Unnamed #37	3	55-29-19	P14	Stevenson Creek		3	
Unnamed #38	3	55-30-24	P14	Stevenson Creek		2	
Unnamed #39	3	55-30-23	P14, P13	Stevenson Creek		2	

Stream Name	Max. Order	Location at Mouth T R S	Map Numbers[1]	Receiving Stream	Original Length (Mi.)	Current Length (Mi.)	Miles Channel-ized
Unnamed #40	3	55-30-25	P14	Crooked River		1	
Unnamed #41	3	55-30-35	P14	Crooked River		2	
Unnamed #42	4	55-30-35	P14, P13	Crooked River	4	3	1
Unnamed #43	3	55-30-34	P14, P13	Unnamed #42		2	

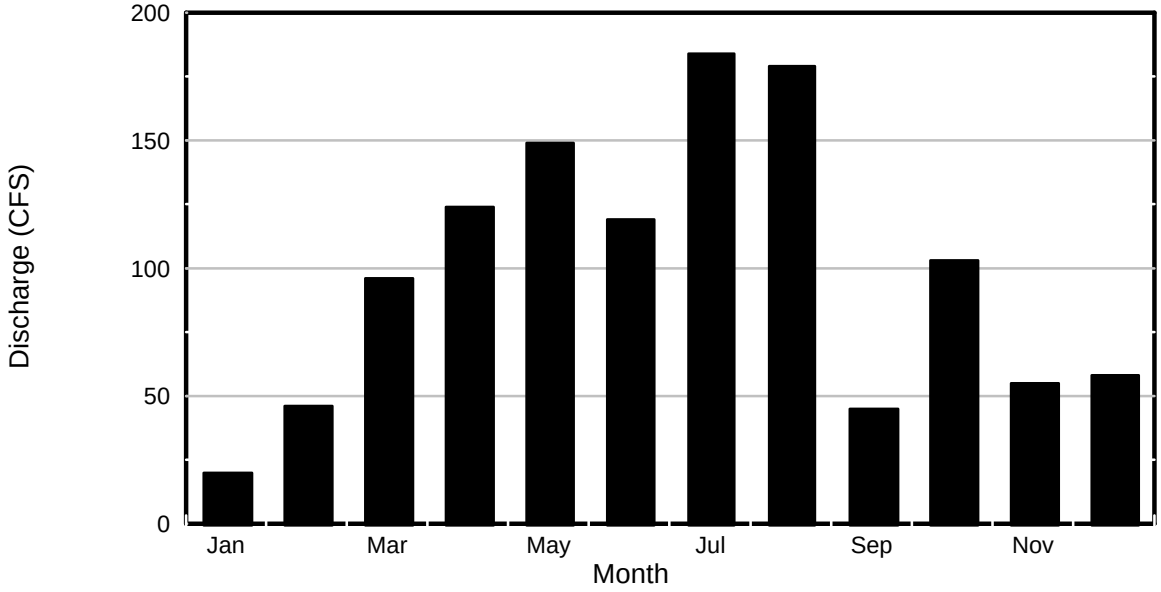

Figure 3. Average annual discharge for the Crooked River basin at gauging station 06895000 near Richmond, Missouri (DuCharme and Miller 1996).

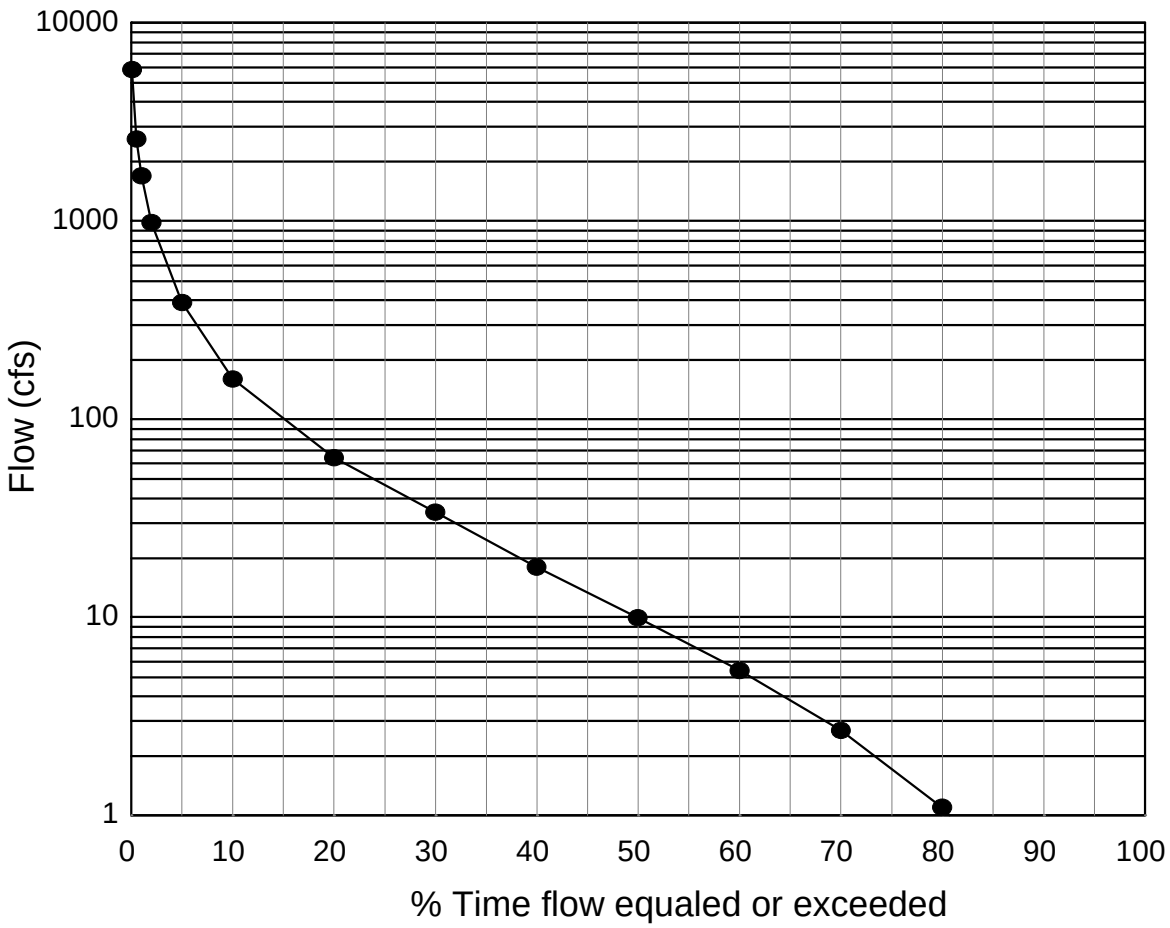

Figure 4. Flow duration curve for the Crooked River near Richmond, Missouri (Skelton 1976).